

### **ABSTRACT OF THE DISCLOSURE**

The invention describes techniques for the control of the spatial as well as spectral beam quality of multi-mode fiber amplification of high peak power pulses as well as using such a configuration to replace the present diode-pumped, Neodymium based sources. Perfect spatial beam-quality can be ensured by exciting the fundamental mode in the multi-mode fibers with appropriate mode-matching optics and techniques. The loss of spatial beam-quality in the multi-mode fibers along the fiber length can be minimized by using multi-mode fibers with large cladding diameters. Near diffraction-limited coherent multi-mode amplifiers can be conveniently cladding pumped, allowing for the generation of high average power. Moreover, the polarization state in the multi-mode fiber amplifiers can be preserved by implementing multi-mode fibers with stress producing regions or elliptical fiber cores. These lasers find application as a general replacement of Nd: based lasers, especially Nd:YAG lasers. Particularly utility is disclosed for applications in the marking, micro-machining and drilling areas.